Use of GPS and InSAR technology and its further development in earthquake modeling

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Abstract

Global Positioning System (GPS) data are useful for understanding both interseismic and postseismic deformation. Models of GPS data suggest that the lower crust, lateral heterogeneity, and fault slip, all provide a role in the earthquake cycle. Future GPS results should also provide insight into fault interactions. Interferometric synthetic aperture radar (InSAR) is also providing valuable crustal deformation data. We are developing analytic and finite element models to be used for the interpretation of geodetic data and earthquake modeling.

Introduction

Global Positioning System (GPS) data, collected since 1986 in southern California, have proved worthwhile in assessing current rates and styles of tectonic deformation. More recently, GPS has been used to measure postseismic deformation following several moderate to large earthquakes. We focus here on GPS results and modeling related to the Ventura and Los Angeles basins, and to the Northridge earthquake. We will also touch on the use of InSAR data and its application to the Northridge earthquake.

GPS Data and Quality

GPS analysis techniques have now improved to the point that daily absolute horizontal and vertical positions can be determined to 3 and 8 mm respectively (Zumberge et al, 1997[9]). Using continuous data horizontal velocities accurate to 1 mm/yr can be achieved in 5 years (Argus and Heflin, 1995[1]. Campaign style measurements can yield velocities accurate to 3–5 mm/yr over two years (Donnellan and Lyzenga, 1998[5]) and to better than 2 mm/yr over longer timespans (Shen et al, 1996[8]).

The 1994 Northridge earthquake provided a catalyst for implementing a densely spaced continuously operating GPS network called the Southern California Integrated GPS Network (SCIGN). When complete the network will consist of 250 stations throughout southern California, but concentrated within the LA basin. Before the earthquake four stations, as part of the Permanent GPS Geodetic Array (PGGA), had been operating in southern California since 1992, and prior to that data were collected in individual campaigns approximately yearly.